SYLLABUS

**Spring 2014**
**ENVR 403: Environmental Chemistry (3 credit hours)**

**Class Meets:** Tuesdays & Thursdays 11:00 AM - 12:15 PM, McGavran-Greenberg Room 2305
**Instructor:** Dr. Jason Surratt, Assistant Professor, Atmospheric & Aerosol Chemist
**Office:** 164 Rosenau Hall
**Email:** surratt@unc.edu
**Office Phone:** 919-966-0470
**Skype Name:** jason_surratt
**Office Hours:** By appointment

**Guest Lecturers:**
Dr. Jason West, Associate Professor in ESE Department, Air Pollution Scientist
Dr. Orlando Coronell, Assistant Professor in ESE Department, Civil & Environmental Engineer
Dr. Theran Riedel, Postdoctoral Scholar in ESE Department, Atmospheric Chemist
Maiko Arashrio, MSEE, PhD Student in Professor Surratt's Group

**Course Description and Goals:** During this course you will study the chemistry of air, water, and toxic organic compounds as well as how anthropogenic activities affect this chemistry on planet Earth. Specifically, we will examine the sources, reactions, transport, effects, and fates of chemical species found in air and water as well as the effects of technology thereon. This course is divided into 4 major parts that reflects the most pressing issues in Environmental Chemistry today: (1) Atmospheric Chemistry and Air Pollution; (2) Climate Change and Energy; (3) Water Chemistry and Water Pollution; and (4) Toxic Organic Compounds. All students who take this course are expected to demonstrate a mastery of all topics through successful completion of quizzes, problem sets, and exams as well as the pollutant assignment.

**Prerequisites:**

This is an advanced undergraduate level course in environmental chemistry, and thus, students are required to have: (1) taken at least one undergraduate course in general chemistry (2) taken at least one undergraduate course in physics; (3) comfort with doing some math. It is strongly recommended that advanced undergraduates that register for this course have had at least one undergraduate course in organic chemistry. This course also serves as an introduction (or "refresher") for first year graduate students pursuing research projects in fields related to environmental chemistry.

**Grading and Course Requirements:**

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|---|---|
| In-class quizzes | 30% |
| Problem sets | 10% |
| Pollutant Assignment | 10% |
| In-class midterm exam | 20% |
| In-class final exam (cumulative) | 30% |
| | 100% |

***Final Grades Assigned:***

| Percentage Score | Grade |
|---|---|
| 93-100 | A |
| 90-92 | A- |
| 87-89 | B+ |
| 83-86 | B |
| 80-82 | B- |
| 77-79 | C+ |
| 73-76 | C |
| 70-72 | C- |
| 67-69 | D+ |
| 60-66 | D |
| <60 | F |

***Instructor's Philosophy of Grading Scale:***

<u>According to the UNC-CH Undergraduate Bulletin and the Registrar's website, permanent grades are defined as follows</u>:

**A** Mastery of course content at the highest level of attainment that can reasonably be expected of students at a given stage of development. The A grade states clearly that the student has shown such outstanding promise in the aspect of the discipline under study that he/she may be strongly encouraged to continue.
**B** Strong performance demonstrating a high level of attainment for a student at a given stage of development. The B grade states that the student has shown solid promise in the aspect of the discipline under study.
**C** A totally acceptable performance demonstrating an adequate level of attainment for a student at a given stage of development. The C grade states that while not yet showing any unusual promise, the student may continue to study in the discipline with reasonable hope of intellectual development.
**D** A marginal performance in the required exercises demonstrating a minimal passing level of attainment for a student at a given stage of development. The D grade states that the student has given no evidence of prospective growth in the discipline; an accumulation of D grades should be taken to mean that the student would be well advised not to continue in the academic field.
**F** For whatever reasons, an unacceptable performance. The F grade indicates that the student's performance in the required exercises has revealed almost no understanding of the course content. A grade of F should warrant an adviser's questioning whether the student may suitably register for further study in the discipline before remedial work is undertaken.

***For <u>graduate students</u> taking this course, they will be graded using the following scale:***
High pass (H) – graduate students in top 10% of class will receive this grade
Pass (P) – most graduate students receive this grade if course work completed adequately
Low Pass (L)
Fail (F) – given if failure to attend lectures or labs, turn in assignments, or adequately complete quizzes/exams

***In-Class Quizzes (30% of grade):*** Except for the first week of class, in-class quizzes will be given **at the beginning of each Tuesday class period**. These quizzes will be closed book and closed notes and should only last about 10 minutes (unless otherwise specified by the instructor). The purpose of the in-class quizzes is to motivate each student to review their lecture notes from the prior week as well as any required readings from the prior week so they stay up-to-speed on the course material. It is possible we may not have a quiz every Tuesday; however, you should be prepared each Tuesday regardless. I will discard your lowest quiz grade before determining your final grade for the course. If you miss a Tuesday class when a quiz is given, you will receive a grade of zero for that quiz but that grade will be the one I discard. You may be excused for missing a quiz if the reason is valid (e.g., family death, or seriously ill) but the lead instructor must approve this. You will also receive a grade of zero for each additional quiz missed after the first. We will likely have up to 8-10 quizzes throughout the semester, and as a result, do not worry if you miss one or do poorly on a couple of quizzes.

***Problem Sets (10% of grade):*** Periodically (i.e., 3-4 times) during the semester, I will handout take home problem sets for you to work through. If you have difficulty with any of these assignments please feel free to schedule a time to meet with me. Problem sets should be turned in on time. Late problem sets will lose 10% for each day it is late. Problem sets may be turned in late only if prior approval of the instructor is given or if there is some very exceptional circumstance that arises (e.g., severe illness, accident). The amount you learn in this course will directly relate to your ability to work problems of this level. In addition to doing the reading assignments and reviewing your lecture notes, understanding the problem sets should help prepare you for any in-class quizzes and exams.

***Environmental Pollutant Assignment (10% of grade):*** This is a two-part assignment. First, you will provide a written report that summarizes the sources, transport, and fates (including chemical reactions) of single pollutant (either organic or metal) released into the environment. Further, you must include a discussion of a recent (last 1-3 years) published research study that examines an aspect of its environmental chemistry. Details of the expectations for this report will be provided in a separate handout. The second part of this assignment will require a formal presentation of the written report during the final week of class. Students will be given 10 minutes for their presentation, with an additional 5 minutes for questions/discussion. Details of the expectations for the presentation will be provided in separate handout. **Written reports are due on Friday, April 11, 2014 by 5 PM**. **Oral presentations (in either pdf or powerpoint format) are due on Friday, April 18, 2014 by 5 PM**.

***In-Class Midterm Exam (20% of grade):*** The date of the in-class midterm exam is **Thursday, March 20, 2014**. This midterm exam will focus only on the atmospheric chemistry, air pollution, and climate change material presented through Thursday, March 6, 2014. This exam will be closed notes and closed book. All necessary equations will be provided to you but no description of what the symbols or meaning of these equations will not be provided.

***In-Class Final Exam (30% of grade):*** The date of the in-class final exam is **Tuesday, April 29, 2014** from **12:00 until 3:00 PM**, in accordance with the UNC exam schedule for classes that meet TH at 11:00 AM. Unlike the midterm exam, you will have 3 hours to complete the in-class final exam. The in-class final exam will also be closed notes and closed book. The in-class final

exam will cover all material discussed during the course. Students are expected to demonstrate a mastery of all major environmental chemistry concepts introduced during this course. This final exam will be held in the same classroom where we meet during the semester.

***Honor Code:*** The University of North Carolina at Chapel Hill has had a student-administered honor system and judicial system for over 100 years. The system is the responsibility of students and is regulated and governed by them, but faculty share the responsibility. If you have questions about your responsibility under the honor code, please bring them to your instructor or consult with the office of the Dean of Students or the Instrument of Student Judicial Governance. This document, adopted by the Chancellor, the Faculty Council, and the Student Congress, contains all policies and procedures pertaining to the student honor system. Your full participation and observance of the honor code is expected.
Students have four general responsibilities under the Honor Code:

1. Obey and support the enforcement of the Honor Code;
2. Refrain from lying, cheating, or stealing;
3. Conduct themselves so as not to impair significantly the welfare or the educational opportunities of others in the University community; and
4. Refrain from conduct that impairs or may impair the capacity of University and associated personnel to perform their duties, manage resources, protect the safety and welfare of members of the University community, and maintain the integrity of the University.

**Textbooks and Other Readings:**

***Required Textbook:***

Colin Baird and Michael Cann, Environmental Chemistry, 5th Edition, 2012.

***Additional Required Readings:*** Research articles or photocopies of chapters from other textbooks may be handed out in class from time-to-time to supplement any of the material that is not adequately covered in the required textbook. Students will be required to read these in order to be better prepared for lectures, quizzes and exams.

***Recommended Textbooks For Part 1 (Atmospheric Chemistry & Air Pollution) of Course for the Interested Readers and Those Pursuing Graduate Studies in this Area of Research:***
John H. Seinfeld and Spyros Pandis, Atmospheric Chemistry and Physics: From Air pollution to Climate Change, 2nd Edition, 2006, Wiley.

Barbara J. Finlayson-Pitts and James N. Pitts, Jr., Chemistry of the Upper and Lower Atmosphere, 1999, Academic Press.

***Recommended Textbooks or Readings for Part 2 (Climate Change & Energy) of Course for the Interested Readers and Those Pursuing Graduate Studies in this Area of Research:***
John Houghton, Global Warming: The Complete Briefing, 4th Edition, 2009, Cambridge Univ. Press. Note: This book is used in Prof. West's class on Climate Change.

The IPCC 5th Assessment Reports (in 3 volumes), available at http://www.ipcc.ch/. We recommend the "Summary for Policymakers" and "Frequently Asked Questions" which communicate well to a general audience.

***Recommended Textbooks For Part 3 (Water Chemistry & Water Pollution) of Course for the Interested Readers and Those Pursuing Graduate Studies in this Area of Research:***
Brezonik, P.L.; Arnold, W.A. Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Systems, Oxford University Press. 2011.

Water Quality and Treatment, 5th edition, R. Letterman, Editor, American Water Works Association, Denver, CO, 1999.

**Class Schedule (subject to updates – T = Tuesdays; H = Thursdays):**

| Day | Day of Month | Month | Topic | Readings | Instructor |
|---|---|---|---|---|---|
| H | 9 | Jan | Course introduction, objectives, policies, and schedule | xix-xxxii | Surratt |
| T | 14 | Jan | **PART 1: Atmospheric Chemistry and Air Pollution** – Introduction to Problem | 1-5, Finalyson-Pitts (2010, PNAS) article and rules of oxidation states | Surratt |
| H | 16 | Jan | Stratospheric Chemistry – The Ozone Layer (Chapter 1): Introduction Part 1 | 6-20 | Surratt |
| T | 21 | Jan | Stratospheric Chemistry – The Ozone Layer (Chapter 1): Introduction Part 2 | 6-20 | Surratt |
| H | 23 | Jan | Stratospheric Chemistry (Chapter 1): Chapman Mechanism & Catalytic Processes of Ozone Destruction Part 1 | 20-33 | Surratt |
| T | 28 | Jan | Stratospheric Chemistry (Chapter 1 & 2): Catalytic Processes of Ozone Destruction Part 2 | 20-33; 37-54 | Surratt |
| H | 30 | Jan | The Ozone Holes (Chapter 2): The Ozone Hole and Other Sites of Ozone Depletion | 37-54 | Surratt |
| T | 4 | Feb | The Ozone Holes (Chapter 2): Chemicals Causing Ozone | 54-63 | Riedel – Surratt will be at field |

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| | | | Destruction | | site in TN |
| H | 6 | Feb | Tropospheric Chemistry (Chapter 3): Introduction | 69-76 | Riedel- Surratt will be at field site in TN |
| T | 11 | Feb | Tropospheric Chemistry (Chapter 3): The Photochemical Smog Process Part 1 | 76-101 | Surratt |
| H | 13 | Feb | Tropospheric Chemistry (Chapter 17): The Photochemical Smog Process Part 2 | 757-770 | Surratt |
| T | 18 | Feb | Tropospheric Chemistry (Chapter 17): The Photochemical Smog Process Part 3 | 757-770 | Surratt |
| H | 20 | Feb | Tropospheric Chemistry (Chapter 3): Particulates in Air Pollution | 118-130 | Surratt |
| T | 25 | Feb | Environmental and Health Effects of Polluted Air (Chapter 4): Acid Rain and Health Effects of Outdoor Air | 135-161 | Surratt |
| H | 27 | Feb | **PART 2: Climate Change & Energy –** Greenhouse Effect (Chapter 5) | 165-219 | West |
| T | 4 | Mar | Global Climate Change (Chapter 6) | 223-288 | West |
| H | 6 | Mar | Energy (Chapters 7-9) | 291-405 | West |
| T | 11 | Mar | ***NO CLASS – Spring Break*** | | |
| H | 13 | Mar | ***NO CLASS – Spring Break*** | | |
| T | 18 | Mar | **Part 3: Water Chemistry and Water Pollution –** Chemistry of Natural Waters (Chapter 10) | 407-450 | Surratt |
| H | 20 | Mar | ***IN-CLASS MIDTERM EXAM*** | | Surratt |
| T | 24 | Mar | Chemistry of Natural Waters (Chapter 10) | 407-450 | Surratt |
| H | 27 | Mar | Pollution and Purification of Water (Chapter 11) | 407-450 | Coronell |
| T | 1 | Apr | Pollution and Purification of Water (Chapter 11) | 455-514 | Coronell |
| H | 3 | Apr | Toxic Heavy Metals (Chapter 12) | 519-570 | Surratt |

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| T | 8 | Apr | Toxic Heavy Metals (Chapter 12) | 573-619 | Surratt |
| H | 10 | Apr | **Part 4: Toxic Organic Compounds**– Pesticides (Chapter 13) | 623-659 | Arashiro |
| T | 15 | Apr | Dioxins, Furans, and PCBs (Chapter 14) | 623-659 | Arashiro |
| H | 17 | Apr | Other Toxic Organic Compounds of Environmental Concern (Chapter 15) | 663-693 | Arashiro |
| T | 22 | Apr | In-Class Presentations of the Organic Pollutant Assignment | 695-750 | Surratt |
| H | 24 | Apr | In-Class Presentations of the Organic Pollutant Assignment | 695-750 | Surratt |
| T | 29 | Apr | ***IN-CLASS FINAL EXAM: 12-3 PM in classroom use throughout spring semester*** | | Surratt |